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LEAF ANATOMY IN CERTAIN STRAINS OF ERAGROSTIS (BEAUV.)

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(With Plates XVIII—XXI.)

ABSTRACT

Five species of Eragrostis were found to show differences in leaf anatomy. Morphologically the species *E. curvula* could be subdivided into five types, while anatomically it was possible to distinguish two groups.

INTRODUCTION

Eragrostis curvula includes strains previously known as *E. chloromelas* and *E. robusta.* After a careful study of the strains known collectively under the name *E. curvula* it has been found possible to group them into five main types. This classification is based primarily on such characters as leaf colour, morphology, inflorescence size and structure, and general growth habit. Although the plants are influenced by growth and fertilizer treatment, the results of further studies (cytology, fertilizer response, weed encroachment, palatability, hay and nutrient yields) tend to support this classification. The types have been named *curvula, chloromelas, robusta blue, robusta intermediate* and *robusta green.* Their morphological characteristics may be summarized as follows:—

1. Robusta blue: broad blue-green leaves, stalkiness resulting in a coarse appearance, tendency towards a decumbent habit, long culm leaves making up a large proportion of the herbage, tall thick culms and large inflorescences.

2. Robusta green: broad, shiny dark green leaves, fewer stalks in comparison with robusta blue, short culm leaves making up only a small portion of the leaf material, and slender culms of medium height.
3. Robusta intermediate: abaxial leaf surface more blue of colour than the adaxial surface, leaves broad and culm leaves short, making up only a small part of the total herbage.
4. Curvula: typical "weeping" habit, long, narrow green leaves and a great predominance of leaf over stalk.
5. Chloromelas: short blue-green leaves with typically curled dead extremities, short flowering culms and finely branched inflorescences.

From time to time, workers have used leaf anatomy as an anatomical character in grasses. It has been shown that large divisions may be distinguished by characteristics of the epidermal elements, such as the presence or absence of hairs, types of silica cells, etc. (Prat 1932, 1936). Genera and species may be separated by studying the arrangement of these elements (Prat 1959). Avdulov (1931) has shown that two distinct types of chloroplasts may occur, while Esau (1953) and Eames and MacDaniels (1951) have demonstrated that differences may occur in the bundle sheaths.

Eragrostis teff, *E. capensis*, *E. plana* and *E. sp.* (collected at Melsetter, Southern Rhodesia) were studied in order to determine whether there was variation in their leaf anatomy, and the same was done for the five types of *E. curvula* described above. Specimens of these grasses are lodged in the Moss Herbarium of the University of the Witwatersrand.

METHODS

Leaves were placed in formalin-aceto-alcohol (F.A.A.) for twenty-four hours, after which they were transferred into 70% ethyl alcohol and stored until needed.

To soften the epidermis and facilitate its removal leaves were placed in a 1 : 1 mixture of pure glycerol and 70% ethyl alcohol for a minimum of 8 hours (Prat 1948). (Treatment in the above fluid should not be continued too long since this makes the material too transparent). Preparations of both the abaxial and adaxial surfaces were made, and mounted in glycerol. Some were tested for silicon with phenol and for cork with iodine, using the methods described by Johansen (1940). (Before phenol is used for silicon staining, it is beneficial to allow the crystals to become pink by leaving them exposed to the air for a few days). Others were left unstained.

Sections 10 to 20 μ thick were cut 1·0—1·5 cm. above the ligule with a freezing microtome and mounted in glycerine jelly.

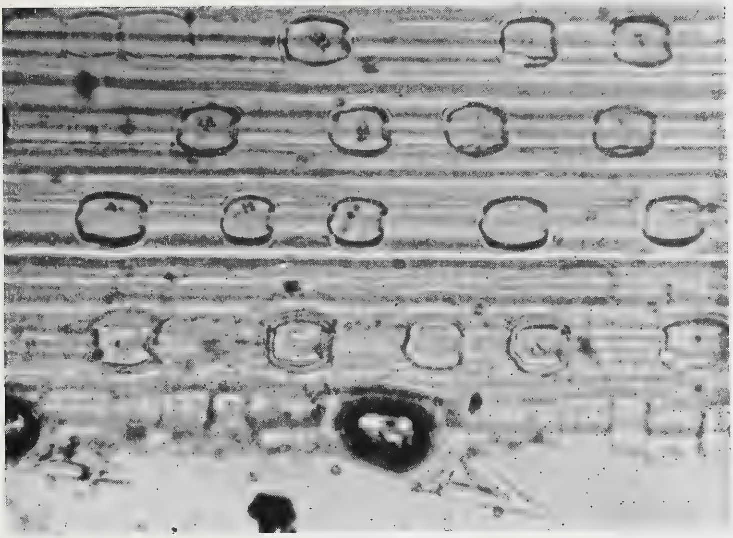


Fig. 1.

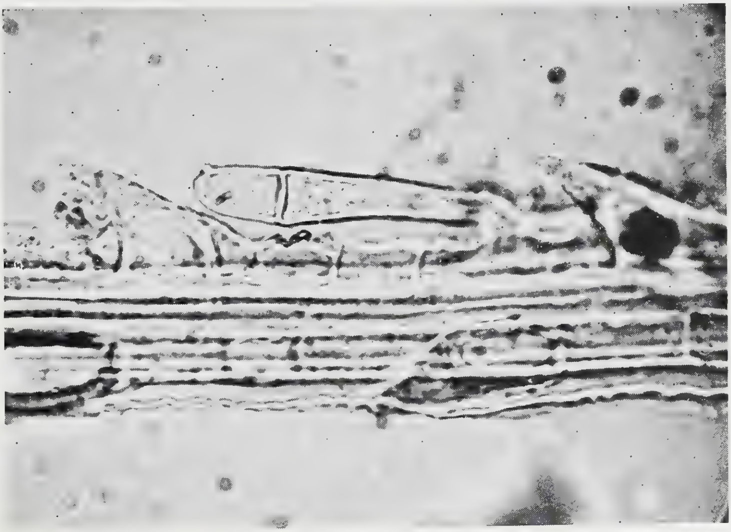
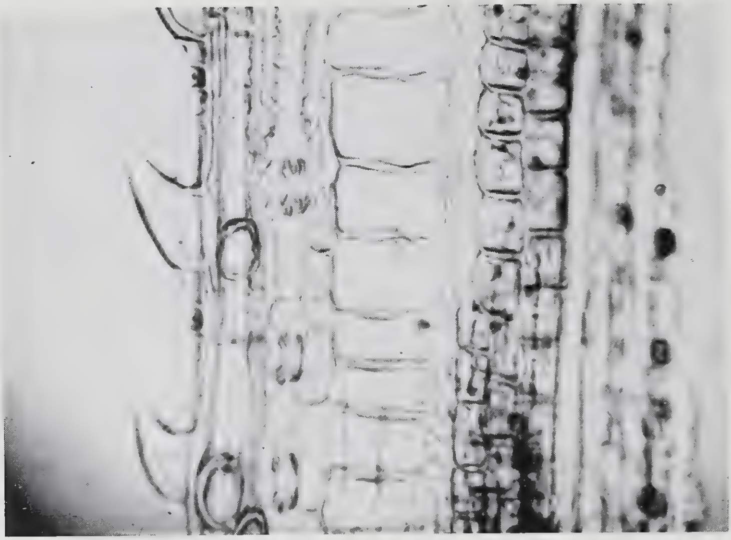


Fig. 2.

Plate XVIII

Figure 1. Adaxial epidermis of *E. robusta* (robusta blue) showing phenol stained silica cells and teeth. Magn. X 968.

Figure 2. Adaxial epidermis of *E. curvula* (No. 10 Tanganyika strain) showing teeth, bicellular hairs and epidermal cells. Magn. X 968.



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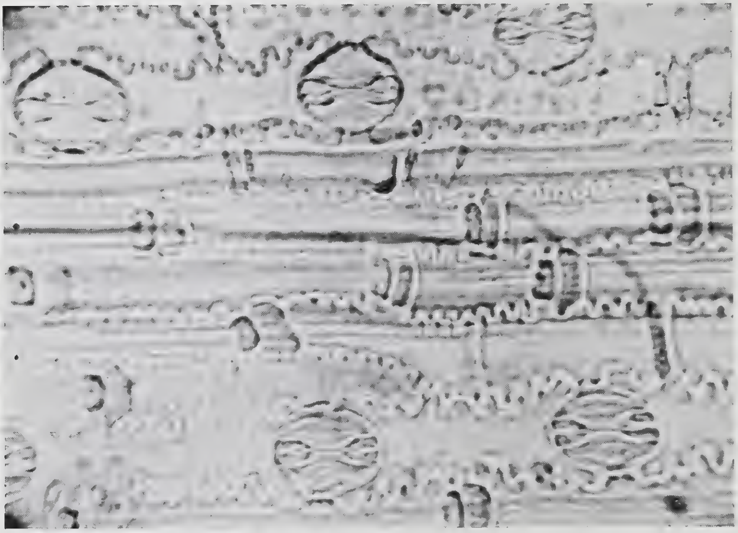
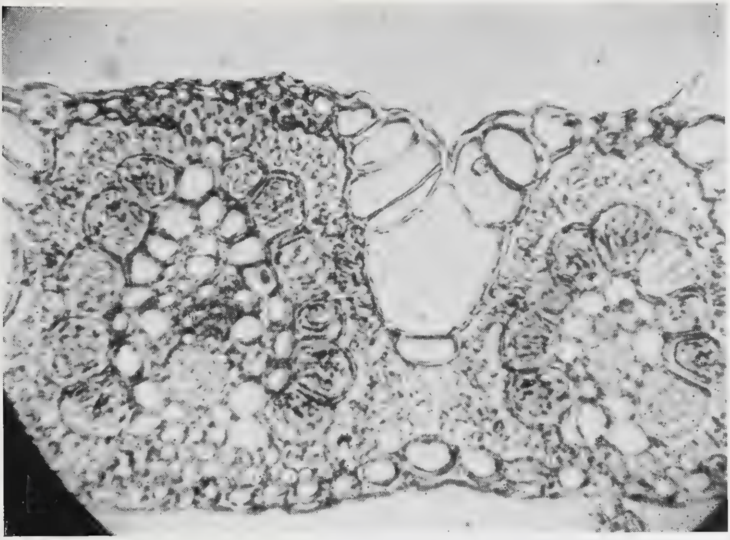


Fig. 2.

PLATE XIX

FIGURE 1. Adaxial epidermis of *E. chloromelas* (No. 79) showing teeth, stomata, motor and epidermal cells. Magn. X 968.

FIGURE 2. Adaxial epidermis of *E. plana* (No. 5 Northan) showing long epidermal cells, shorter cells between the stomata, silica cells and cork cells. Magn. X 968.



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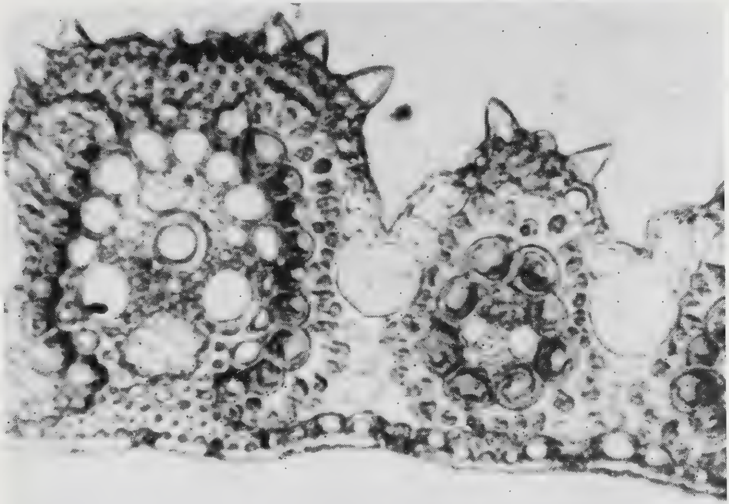


Fig. 2.

Plate XX.

Figure 1. Leaf section of *E. capensis*. Magn. X 563.
Figure 2. Leaf section of *E. teff*. Magn. X 563.

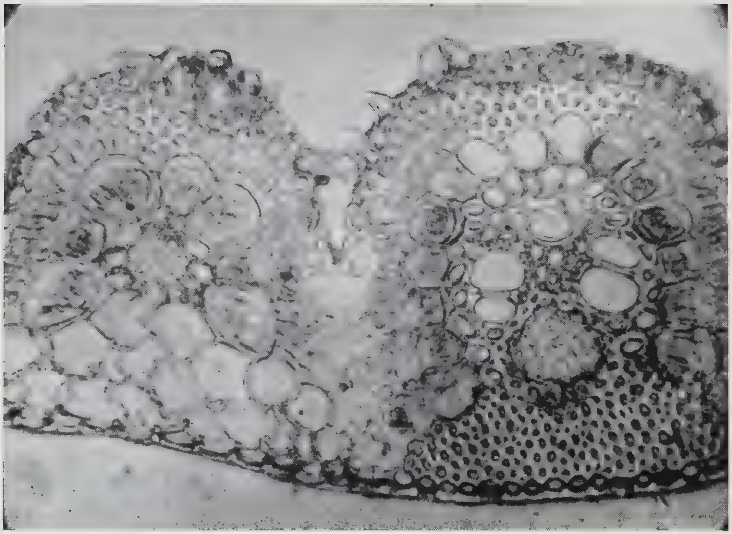


Fig. 1.

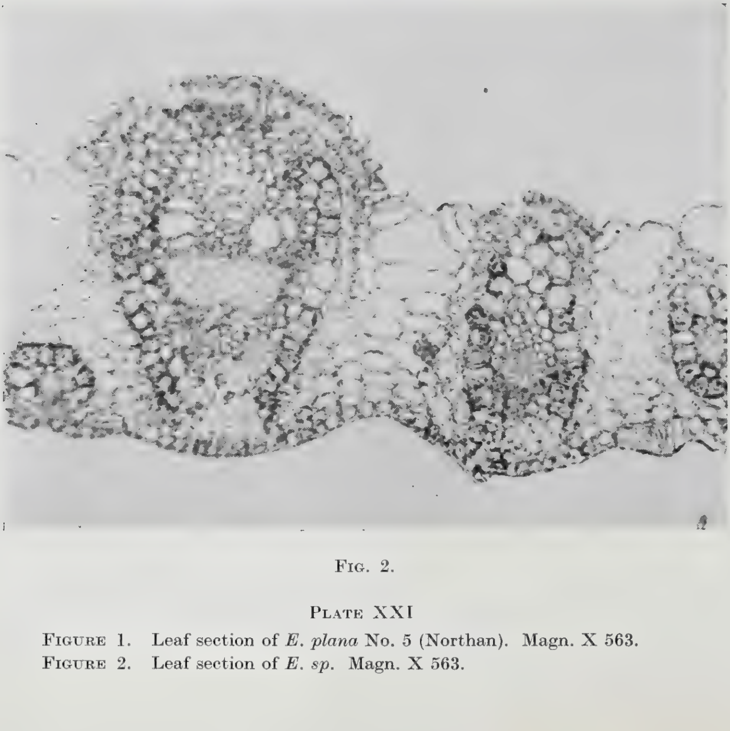


Fig. 2.

Plate XXI

Figure 1. Leaf section of *E. plana* No. 5 (Northan). Magn. X 563.

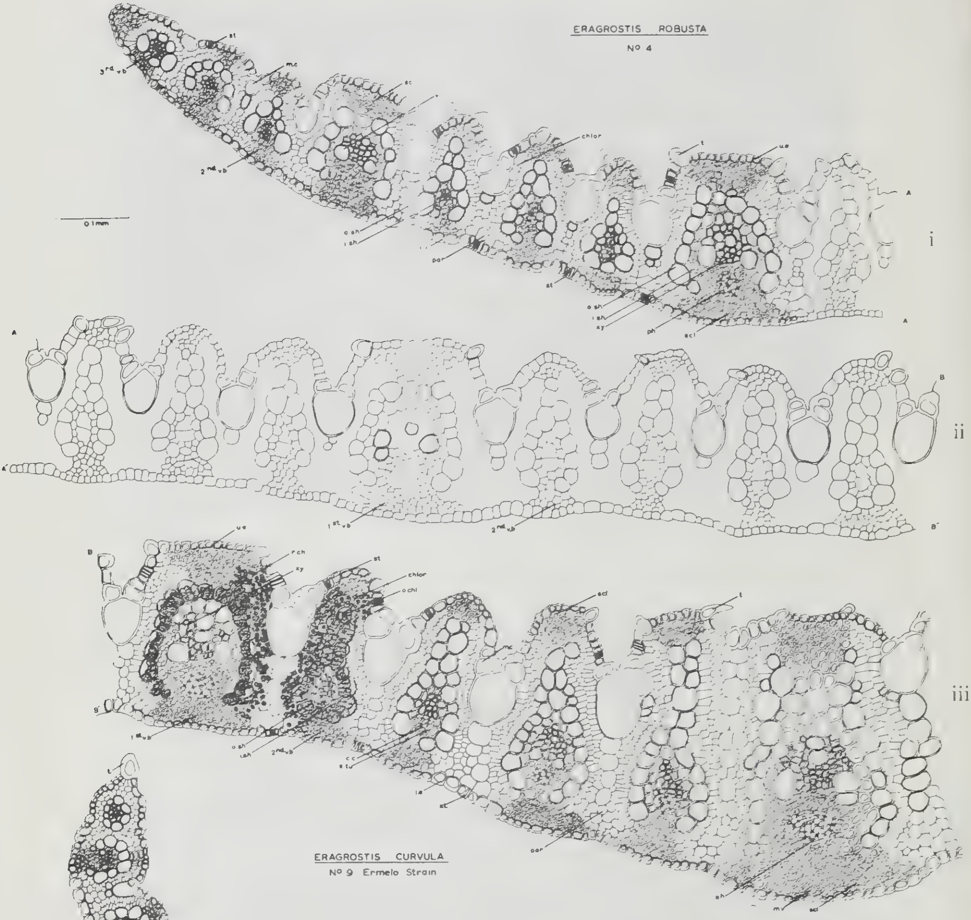
Figure 2. Leaf section of *E. sp.* Magn. X 563.

RESULTS

In all the specimens studied the epidermis showed a complex structure as is typical of the Gramineae, viz.: long cells and two kinds of short cells: silica and cork cells, which occurred in pairs. The silica cells were always hatchet-shaped (Plate XVIII, Fig. 1). Some short cells had developed protrusions in the form of short clavate bicellular hairs (Plate XVIII, Fig. 2) and others developed bulbose silicified teeth (Plate XVIII, Fig. 2 and Plate XIX, Fig. 1.) *E. sp.* showed the formation of long hairs with pointed apices in addition.

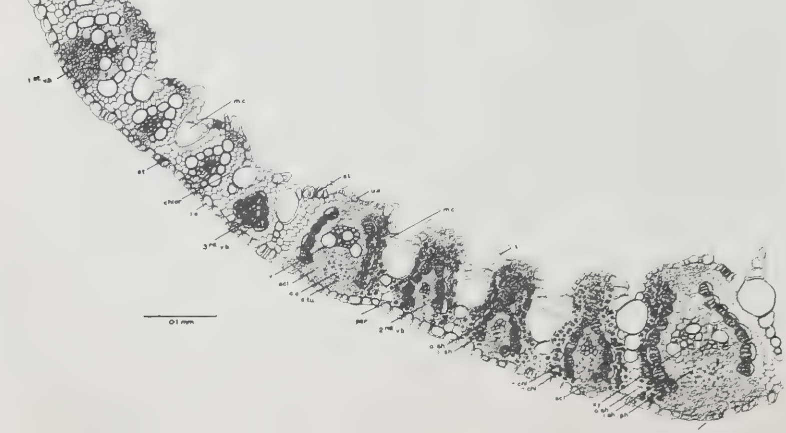
The epidermal cells were arranged in parallel rows, but the composition of these rows varied in different parts of the leaf. The basal region of the adaxial surface of the leaf sheath had a homogeneous epidermis composed of long cells only. Elsewhere in the leaves various combinations of the different cell types, mentioned above, were found. In the adaxial epidermis motor cells, epidermal cells and stomata were found in between the veins (Plate XIX, Fig. 1), while elongated cells combined with cork and silica cells occurred above the veins. In surface view the motor cells had smooth, thin walls and were rectangular in shape. Stomata occurred adjacent to these motor cells. Three to five parallel rows of teeth were found above each vein; their shape varied in the different species. In *E. capensis* and *E. sp.* they were short and straight, while in *E. curvula*, *E. plana* and *E. teff* they were slightly recurved. In the abaxial epidermis the cells between the nerves were ripple-walled, rectangular in shape and interrupted at intervals by stomata and solitary cork cells, or by cork and silica cells (Plate XIX, Fig. 2). In *E. curvula* types the differences were quantitative rather than qualitative.

The internal leaf anatomy of all the *Eragrostis* species and strains followed the same basic pattern. In certain strains first-, second- and one or two third-order vascular bundles were present, while in others only first- and third-order bundles occurred. Two sheath layers surrounding each vascular bundle were found. In all cases the outer sheath was well developed and contained large chloroplasts arranged in the form of a fan (Fig. 1, iii and iv). The internal sheath was of thick-walled sclerenchyma and was present in all vascular bundles. The outer sheath layer was surrounded by elongated, parenchyma cells which contained small, round chloroplasts. Each vascular bundle was separated from the neighbouring bundles by large parenchyma cells without chloroplasts. The motor cells were bigger than the ordinary epidermal cells and were arranged in rows extending throughout the length of the leaf upon its upper surface. They frequently occurred at the bottom of well defined grooves. Next to the groups of motor cells were cell types transitional between typical motor cells and the ordinary epidermal cells.



ERAGROSTIS ROBUSTA

No 4



ERAGROSTIS CURVULA

No 9 Ermelo Strain

In the *E. curvula* strains studied two groups of anatomical arrangements were found. Camera lucida drawings made of these are shown in Fig. 1, i, ii, iii and iv, and the features are summarised below.

Leaf Anatomy in Certain Strains of Eragrostis (Beauv).———

Group 1 (Fig. 1, i, ii and iii). Found in robusta blue, robusta intermediate and robusta green; leaves broad and with a basic pattern of three or four second-order vascular bundles situated between two first-order bundles repeating itself approximately eight times along the breadth of the leaf; first-order bundles broad and the adaxial epidermal surface above these bundles flat; motor cells in depressions between the bundles, as found in all *E. curvula* strains; mid-vein usually a single bundle, but nearer ligule two third-order bundles could be found on either side.

Group II (Fig. 1, iv). Found in curvula and chloromelas; leaves narrow and with approximately four repeating units, smaller bundles with fewer cells as compared to Group 1 and adaxial epidermal surface above the bundles rounded.

The anatomical features of the other four species were as follows:—

E. capensis (Plate XX, Fig. 1). Leaves broad with many first- and third-order vascular bundles, mid-vein simple, usually three third-order bundles situated between two first-order bundles, little sclerenchyma, motor cells not sunken and adaxial leaf surface even.

E. teff (Plate XX, Fig. 2). Leaves broad, mid-rib region thick and made up of a number of bundles above which there were several layers of parenchyma, three or four third-order bundles situated between two first-order bundles, first-order bundles larger than third-order bundles, motor cells sunken, uneven adaxial surface, adaxial epidermal surface above third-order veins rounded and little sclerenchyma.

E. plana (Plate XXI, Fig. 1). Leaves of moderate width, mid-rib region made up of seven bundles arranged in the shape of a 'U' with enclosed portion between arms of the 'U' filled with parenchyma, large broad first- and third-order bundles alternated

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Figure 1

i, ii, and iii. *Eragrostis robusta* No. 4.

vi. *Eragrostis curvula* No. 9, Ermelo stra. in m.v. mid-vein; 1st v.b. first-order vascular bundle; 2nd v.b. second-order vascular bundle; 3rd v.b. third-order vascular bundle; ph. phloem; cc. companion cell; s. tu. sieve tube; xy. xylem; v. vessel; scl. sclerenchyma; par. parenchyma; chlor. chlorenchyma; o. sh. outer bundle sheath; i. sh. inner bundle sheath; st. stoma; t. tooth; u.e. upper epidermis; l.e. lower epidermis; m.c. motor cell; r.chl. round chloroplasts; o.chl. oblong chloro-plasts.

The distribution of chloroplasts is indicated in certain regions only.

with one another in the remainder of the leaf, motor cells sunken and comparatively small, adaxial epidermal surface above bundles rounded, and with large parenchyma cells beneath third-order bundles.

E. sp. (Plate XXI, Fig. 2). Arrangements of the first-, second- and third-order bundles variable, first-order bundles large and pear-shaped with the broader side uppermost and projecting beyond the general level of the second-order bundles, motor cells more numerous and vascular bundles separated by broader zones of parenchyma than in the other species.

CONCLUSIONS

The leaves of each species possessed characteristic anatomical features. In *E. curvula* two groups of anatomical arrangements were found, represented by robusta blue, robusta intermediate and robusta green types, and the curvula and chloromelas types respectively. The differences between these two groups occurred in the number of vascular bundles present, this being correlated with leaf size, the number of cells making up each vascular bundle and other associated tissues, and the shape of the adaxial epidermal surfaces above the vascular bundles. As qualitative differences were not found between all five types of *E. curvula,* the use of anatomical features as a method of separating these types is not practical.

ACKNOWLEDGEMENTS

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